Figure 4: Dissolved Oxygen above the J-town WWTP

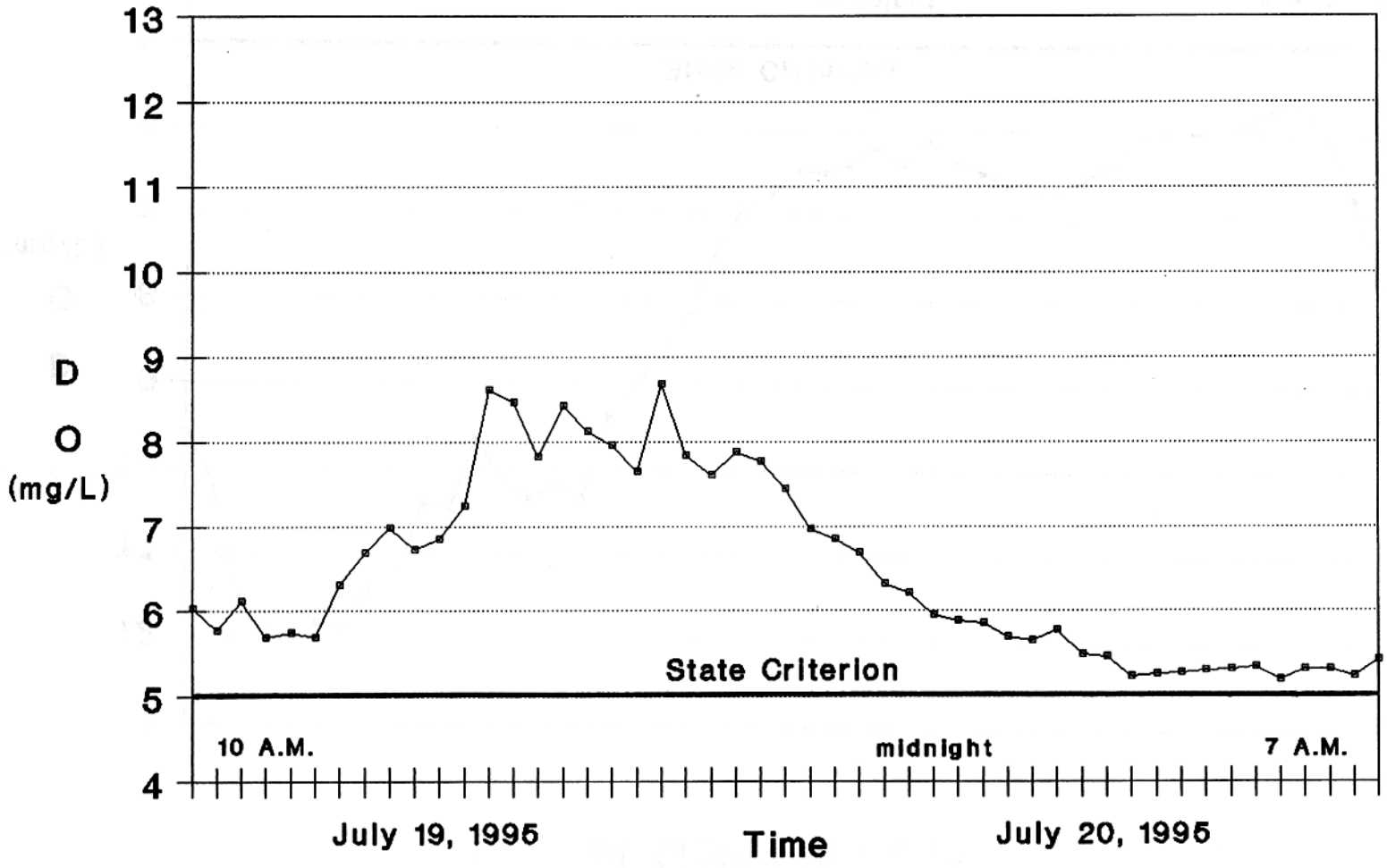


Figure 5: Dissolved Oxygen at Gelhaus Lane

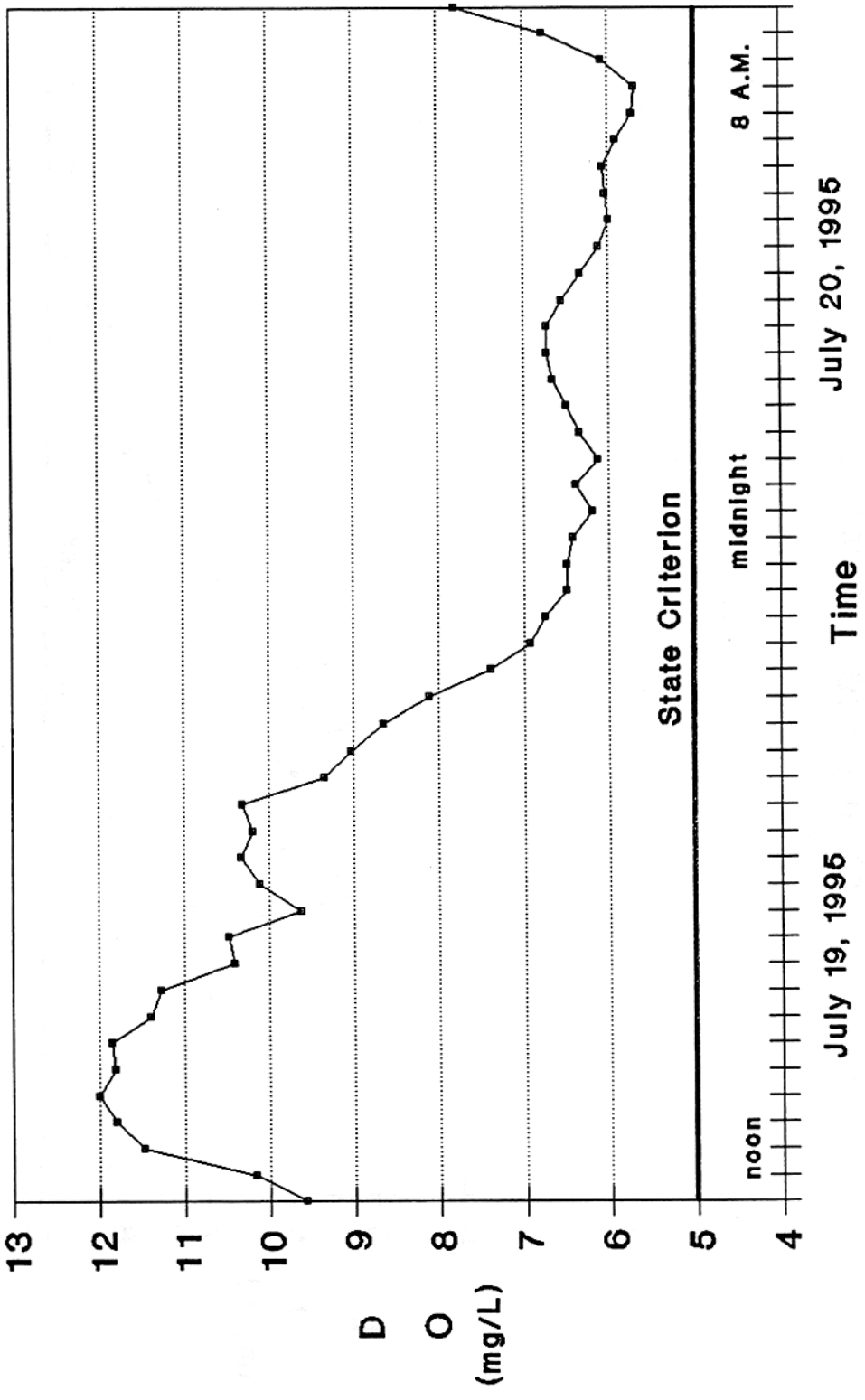


Figure 6: Dissolved Oxygen at Seatonville Road

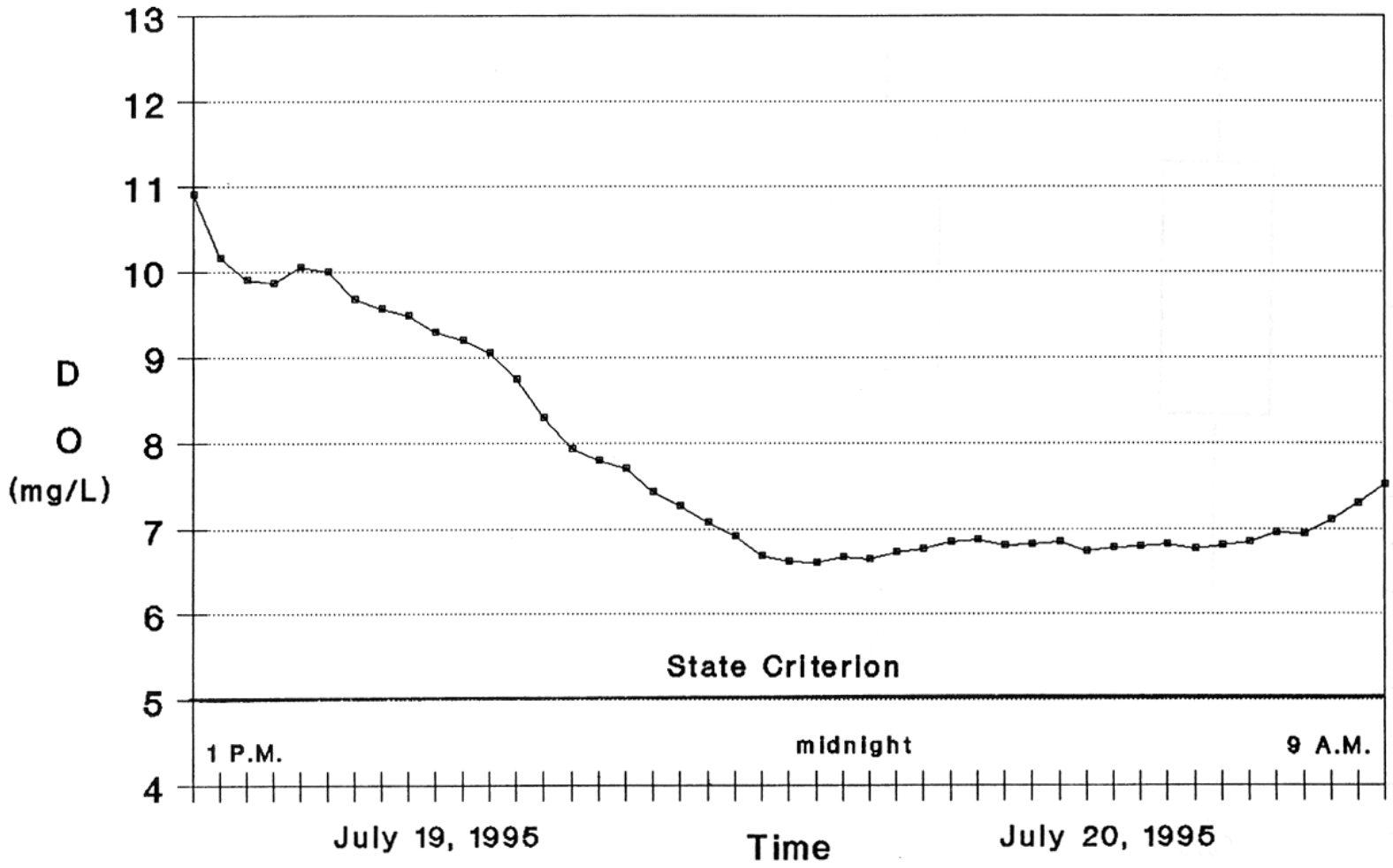
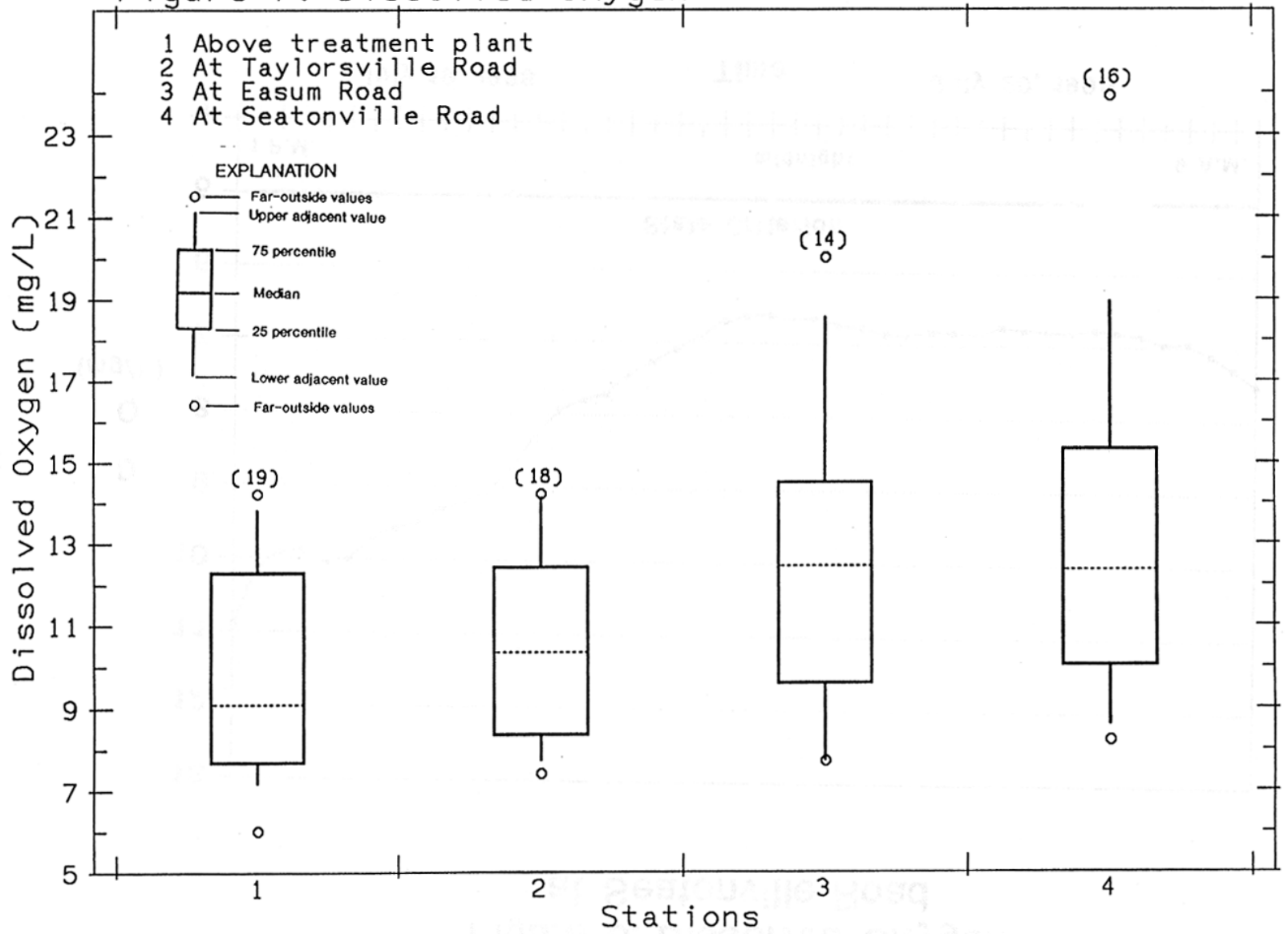


Figure 7. Dissolved Oxygen in Chenoweth Run in 1995



Algal activity also affects the pH of a stream. The pH will increase as algae increase their photosynthetic activity and uptake of carbon dioxide during daylight hours and decrease at night when algae are releasing carbon dioxide in respiration (Palmer, 1959). Over a 24-hour period on July 19 and 20, pH ranged from 8.0 to 8.4 units at the station above the J-town WWTP, 7.8 to 9.5 units at the Gelhaus Lane station, and 8.1 to 9.1 units at the Seatonville Road station. The highest values occurred in late af ternoon and the lowest values at night. This again indicates significant algal activity below the J-town WWTP. A box plot of pH data also indicates elevated levels downstream of the facility (Figure 8). The pH of a stream is important because of its relationship to ammonia toxicity. At high summer temperatures and high pH (considered greater than about 8.5 units), ammonia becomes toxic to aquatic life, even at the relatively low ammonia concentrations found in Chenoweth Run. This again points to the importance of nutrient control to reduce algal biomass and subsequent water quality problems.

The J-town WWTP is consistently in compliance with BOD, ammonia, and total suspended solids (TSS) permit limits. The effluent does not negatively impact Chenoweth Run for these parameters (Table 3, Figures 9, 10, and 11). BOD and ammonia are fairly low throughout the stream. Total suspended solids, however, are high after storm events, with the maximum value of 440 mg/L measured above the treatment plant. This is likely caused by quick

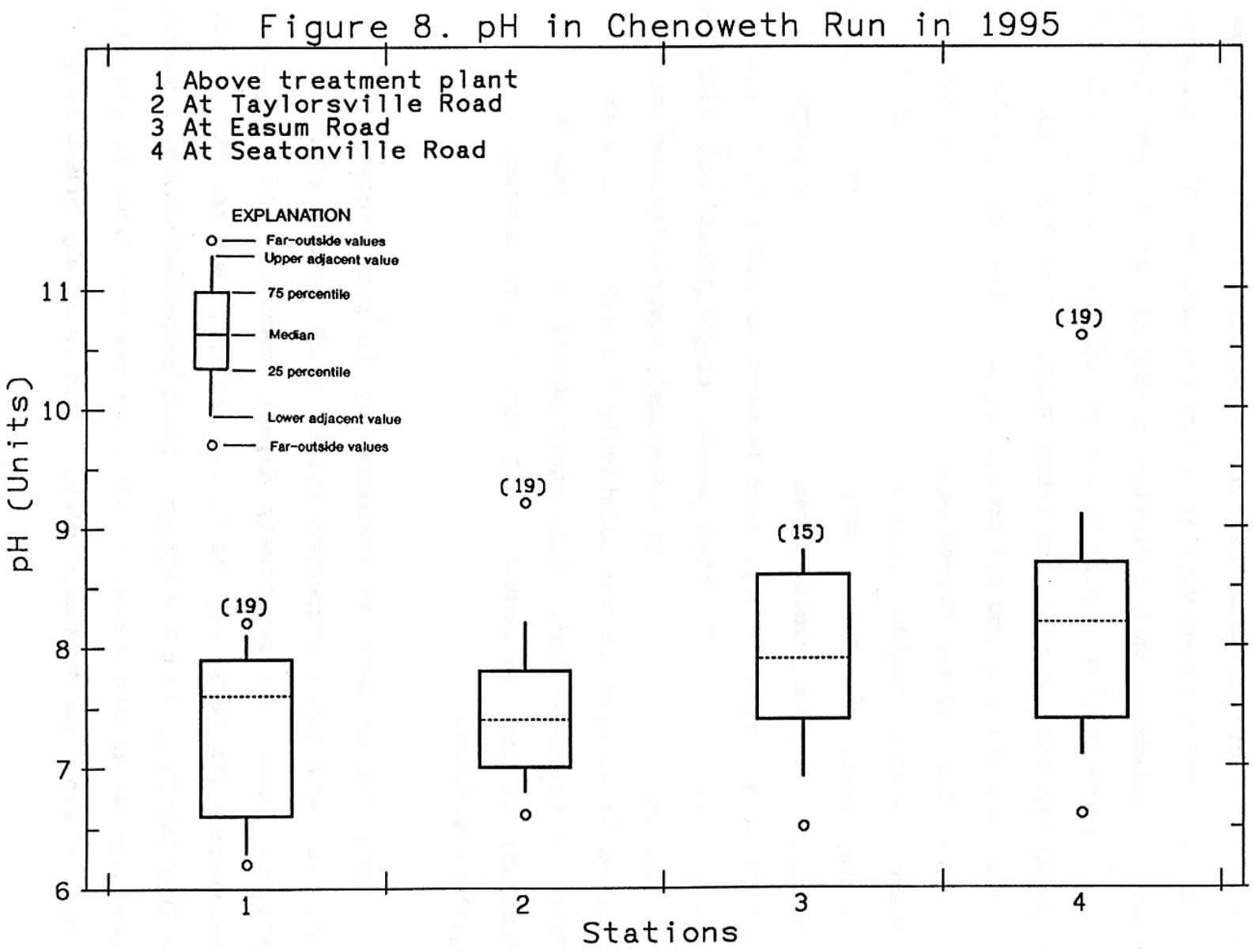


Figure 8. pH in Chenoweth Run in 1995
1 Above treatment plant
2 At Taylorsville Road
3 At Easum Road
4 At Seatonville Road
EXPLANATION
Far-outside values
Upper adjacent value
75 percentile
Median
25 percentile
Lower adjacent value
Far-outside values
pH (Units)
11
10
9
8
7
6
(19)
(19)
(15)
(19)
1
2
3
4
Stations

Figure 9. BOD in Chenoweth Run in 1995

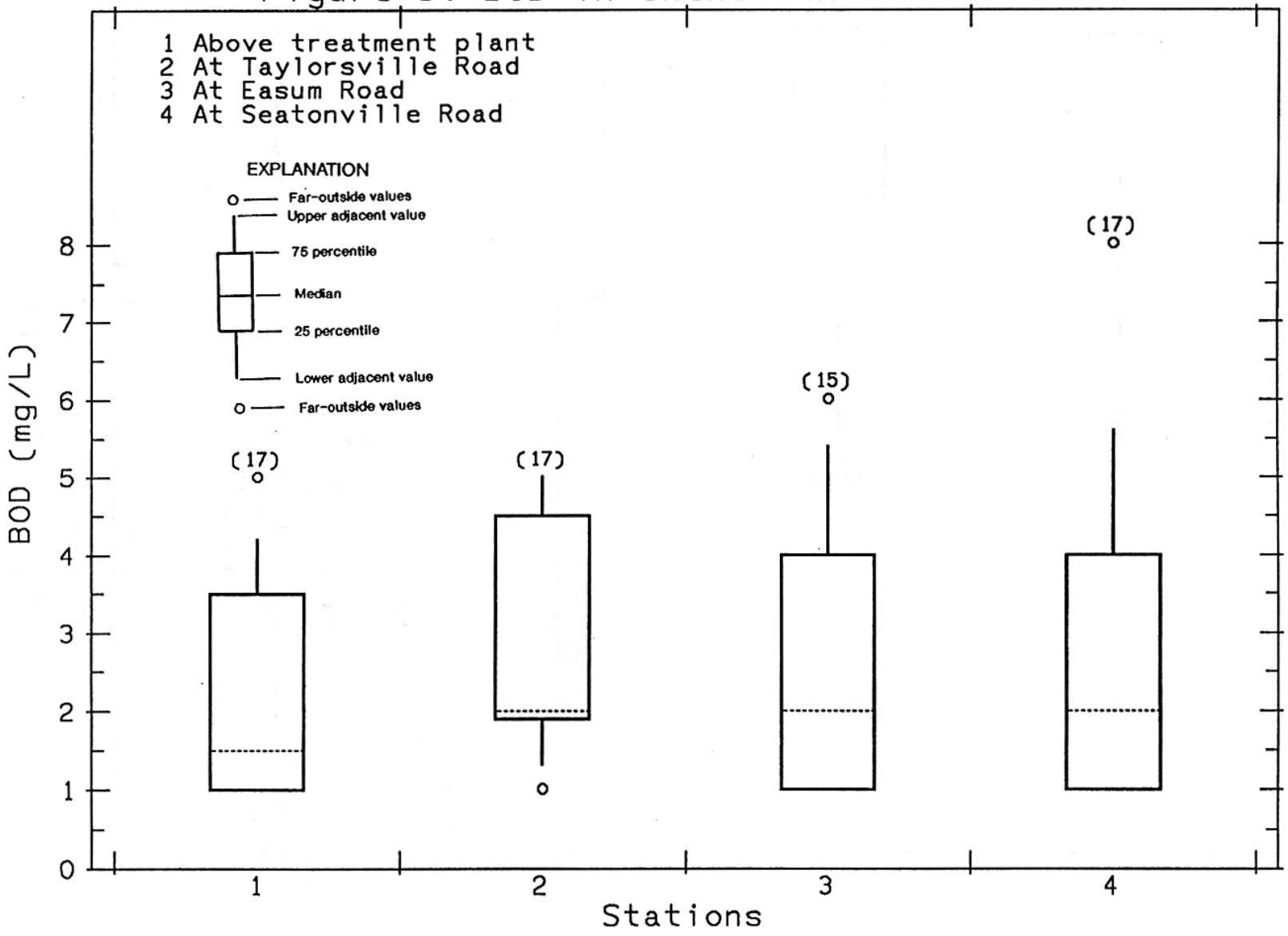


Figure 10. Ammonia Nitrogen in Chenoweth Run in 1995

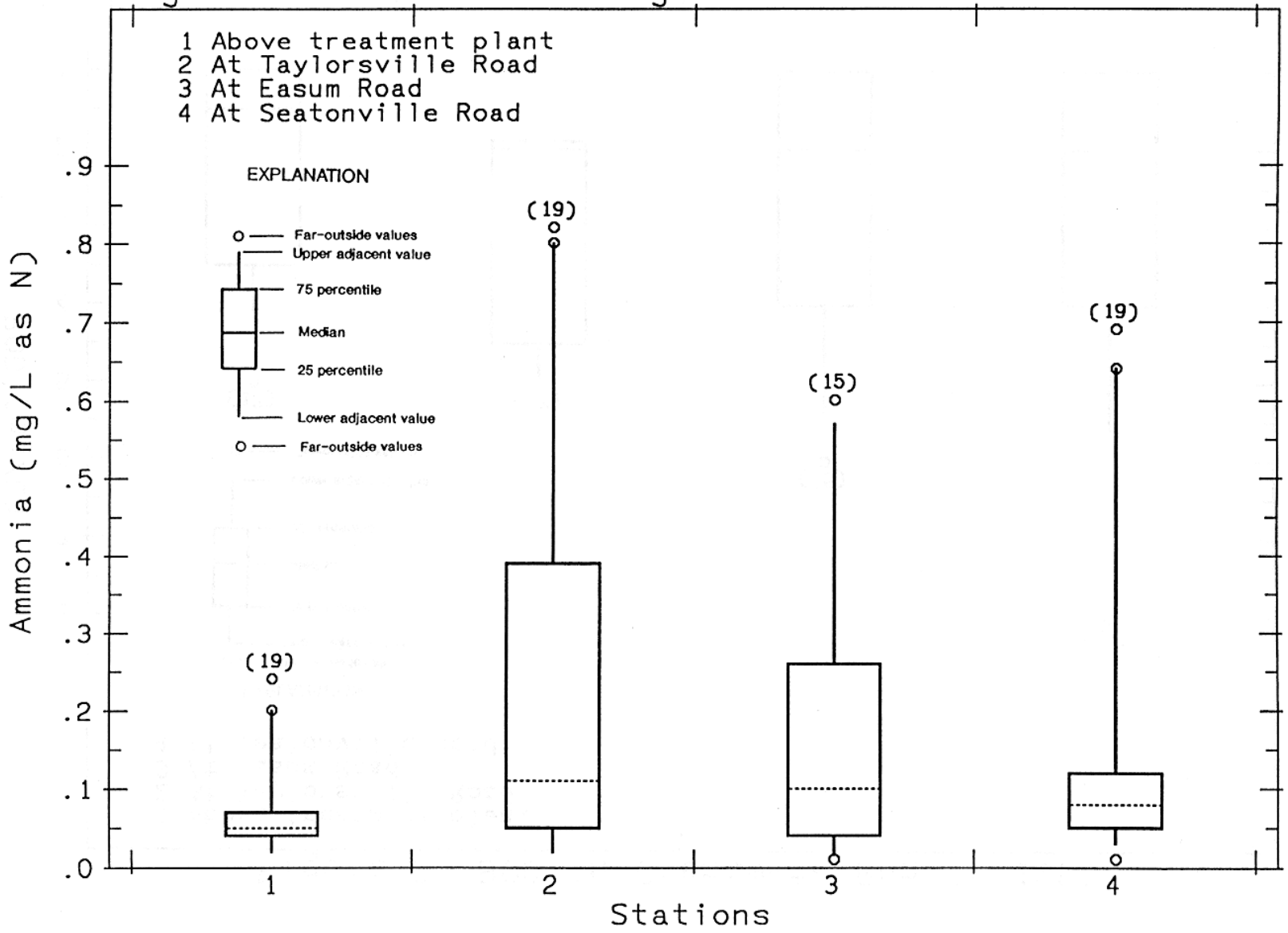
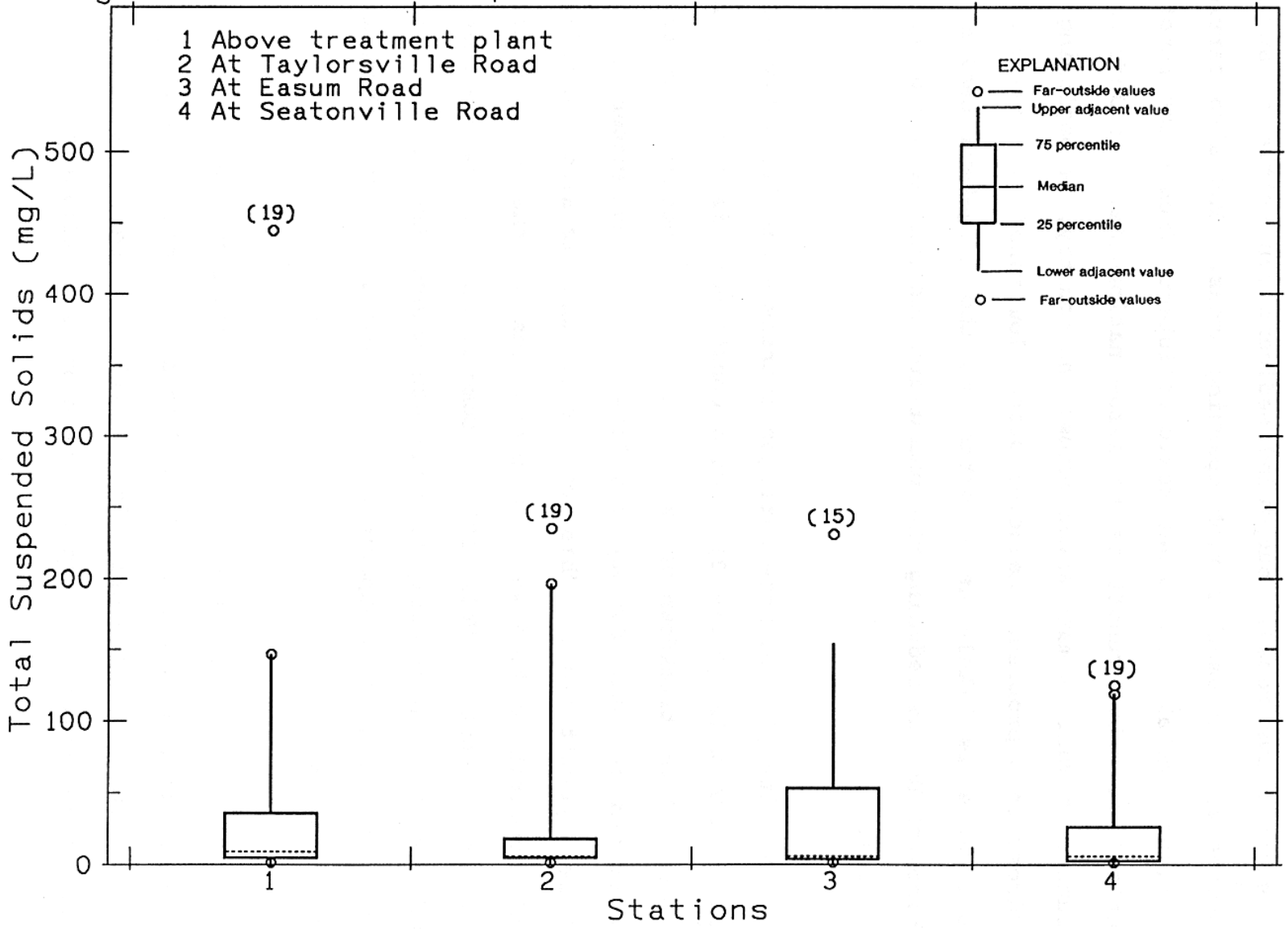


Figure 11. Total Suspended Solids in Chenoweth Run in 1995



storm load runoff from urban, industrial, and construction sites. As storm flows recede, suspended sediment can settle to stream bottoms and can smother fish spawning areas. TSS also carries nutrients, metals, and other toxic pollutants from urban runoff. Control of urban runoff is an issue nationwide, and Jefferson County, as well as many areas across the country, is beginning to address this problem. Reducing storm-flow runoff and associated pollutants is likely as important to the long-term health of Chanoweth Run as reducing the summertime nutrient load from point sources.

Nitrite plus nitrate nitrogen increases signif icantly below the J-town WWTP (Table 3). This constituent is a natural by-product of the breakdown of ammonia and is not uncommon. There is no stream standard for aquatic life for this parameter, nor is there a permit limit. This form of nitrogen is also a nutrient, but researchers believe that phosphorus is the most critical nutrient to control (Velz, 1970). Some forms of algae are able to utilize nitrogen directly from the atmosphere, thus a stream poor in nitrogen may still experience algal blooms if excess phosphorus is available.

Samples for metals were collected once during a low flow and once during a storm event. These data are presented in Appendix I. No violations of metal criteria were noted during the period of low flow at any stream station or treatment plant effluent. Iron and

lead violated chronic stream criteria for these metals (1.0 mg/L and 0.008 mg/L at an average stream hardness of 200 mg/L, respectively) at the high-flow event at all stream stations but not in the effluent. It should be noted that chronic criteria are established to protect aquatic life from long-term exposure and may not be important from short-term exposure found in storm events. Iron also violated the acute criterion of 4 mg/L at all stream stations, but not in the effluent. Iron is associated with soil particles, and sediment-laden runoff is likely the source of high iron concentrations found in high stream flows. This again points out the need to better control urban storm water runoff.

PREVIOUS STUDIES

Other data have been collected previously in Chenoweth Run, and a number of reports have been written. These are listed in the References. Most of these studies did not focus on Chenoweth Run, but include samples f rom Chenoweth Run as part of the overall projects. The KDOW published a study of Floyds Fork in 1986 and included samples from Chenoweth Run at Seatonville Road. MSD, in cooperation with the USGS, began sampling stream sites across Jefferson County in 1988 and continues to sample these today. The MSD station on Chenoweth Run is at Gelhaus Lane.

The 1986 KDOW study found significant nutrient enrichment problems in Chenoweth Run and in Floyds Fork below Chenoweth Run. "The aquatic biota has been adversely impacted in Chenoweth Run and in areas downstream from its conf luence with main stem Floyds Fork" (KDOW 1986). It was noted that Chenoweth Run had dense growths of algae, and tree cover to provide shade was limited. This was stated to contribute to algal growth. Dissolved oxygen was measured as greater than 20 mg/L, and pH was 9.2. Total phosphorus was 1. 44 mg/L. These samples were collected from a one-time sampling trip during low-flow, summertime conditions.

MSD has published reports on overall stream quality throughout Jefferson County for data collected in 1989, 1990, 1991/1992 (three reports), plus a report of data collected in Chenoweth Run from 1991 to 1994. Water quality problems abound in urban areas, and

Jefferson County is no exception. "As streams are relocated (for development) and vegetation is removed, the surrounding terrain loses its ability to hold water, and there is increased runoff and erosion. This results in rapidly fluctuating levels of flow in the streams and usually results in increased amounts of silting, increased numbers of coliforms (bacteria), increased oxygen demand, and other factors that contribute to the general deterioration of water quality in the streams" (MSD 1991).

MSD reported that fecal coliform bacteria violate the primary contact recreation criteria at every sampling station in the county. Nutrient concentrations are elevated in most streams, and metals criteria are violated occasionally at numerous stations. Nuisance algal growths are common in many of the streams in Jefferson County. Biotic Index Values, a measure of the biological integrity of streams, show moderate to severe impact throughout the county. Chenoweth Run at Gelhaus Lane has had violations of copper, mercury, cadmium, lead, zinc, and fecal coliform bacteria with a biotic index value that shows a severe level of impact. Sampling for cyanide, pesticides, and herbicides also has found occasional violations of stream criteria. MSD reported for Chenoweth Run that "extremely abundant growths of filamentous algae develop during warmer periods" (MSD 1996). These problems are considered to be from both point and nonpoint sources.

MSD has undertaken a number of programs to alleviate stream problems in Jefferson County. These include 'storm water permitting programs, point and non-point pollution sources, CSO (combined sewer overflow) impact reduction studies, flow fluctuation abatement programs, flood hydrograph studies, dissolved oxygen model development, development of watershed simulation models, continued construction of a county-wide system of sewers and elimination of small package plants. The impacts of these and other programs will continue to be monitored to assess their eventual impact on stream quality with on-going recovery studies (designed to assess the impacts of MSD management decisions and capital projects) and a continuation of the water quality monitoring program" (MSD 1994).

In an effort to assess the impact that Chenoweth Run may be having on Floyds Fork, a summary of previously published data is presented in Table 4. Of the parameters examined, it appears that phosphorus contribution from Chenoweth Run is having the most impact on Floyds Fork. The median total phosphorus concentration in Floyds Fork at Taylorsville Road, near Fisherville at mile 32.7, was 0.17 mg/L from 86 measurements collected from 1988 to 1992. Chenoweth Run flows into Floyds Fork at mile 24.2. The median phosphorus concentration in Chenoweth Run at Gelhaus Lane during this period was 1.6 mg/L. The median phosphorus concentration in Floyds Fork at Bardstown Road, downstream of Chenoweth Run and at mile 18.7, was 0.35 mg/L. Figure 12 shows total phosphorus

Table 4. Data in Floyds Fork and Chenoweth Run from 1988 to 1992

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
Total Suspended Solids (mg/L)								
Floyds Fk at Taylorsville Rd	91	2.	4.2	8.0	16	30	102	1640
Chen. Run at Gelhaus Lane	89	0.7	2.0	5.0	8.0	16	48	502
Floyds Fk at Bardstown Rd	90	<1.	3.1	7.0	15	27	106	302
Dissolved Oxygen (mg/L)								
Floyds Fk at Taylorsville Rd	95	3.0	6.2	7.5	8.9	12	13	16
Chen. Run at Gelhaus Lane	94	6.6	7.8	9.0	11	13	14	17
Floyds Fk at Bardstown Rd	95	4.2	5.8	7.5	9.0	12	13	16
pH (standard units) **								
Floyds Fk at Taylorsville Rd	74	6.6	7.6	7.7	7.9	8.2	8.4	9.0
Chen. Run at Gelhaus Lane	74	6.2	7.5	7.7	7.9	8.1	8.6	9.3
Floyds Fk at Bardstown Rd	75	6.9	7.6	7.7	7.9	8.1	8.2	8.6
BOD (mg/L)								
Floyds Fk at Taylorsville Rd	91	<2.0	(1.1)	2.0	2.0	6.2	9.0	14
Chen. Run at Gelhaus Lane	90	<2.0	(1.2)	2.0	3.0	6.6	13	23
Floyds Fk at Bardstown Rd	90	<2.0	(1.0)	1.6	2.2	4.3	9.3	14
Total Phosphorus (mg/L)								
Floyds Fk at Taylorsville Rd	86	0.03	0.07	0.11	0.17	0.28	0.48	1.5
Chen. Run at Gelhaus Lane	86	0.15	0.34	0.80	1.6	2.6	3.5	12
Floyds Fk at Bardstown Rd	86	0.05	0.13	0.23	0.35	0.79	1.3	5.8

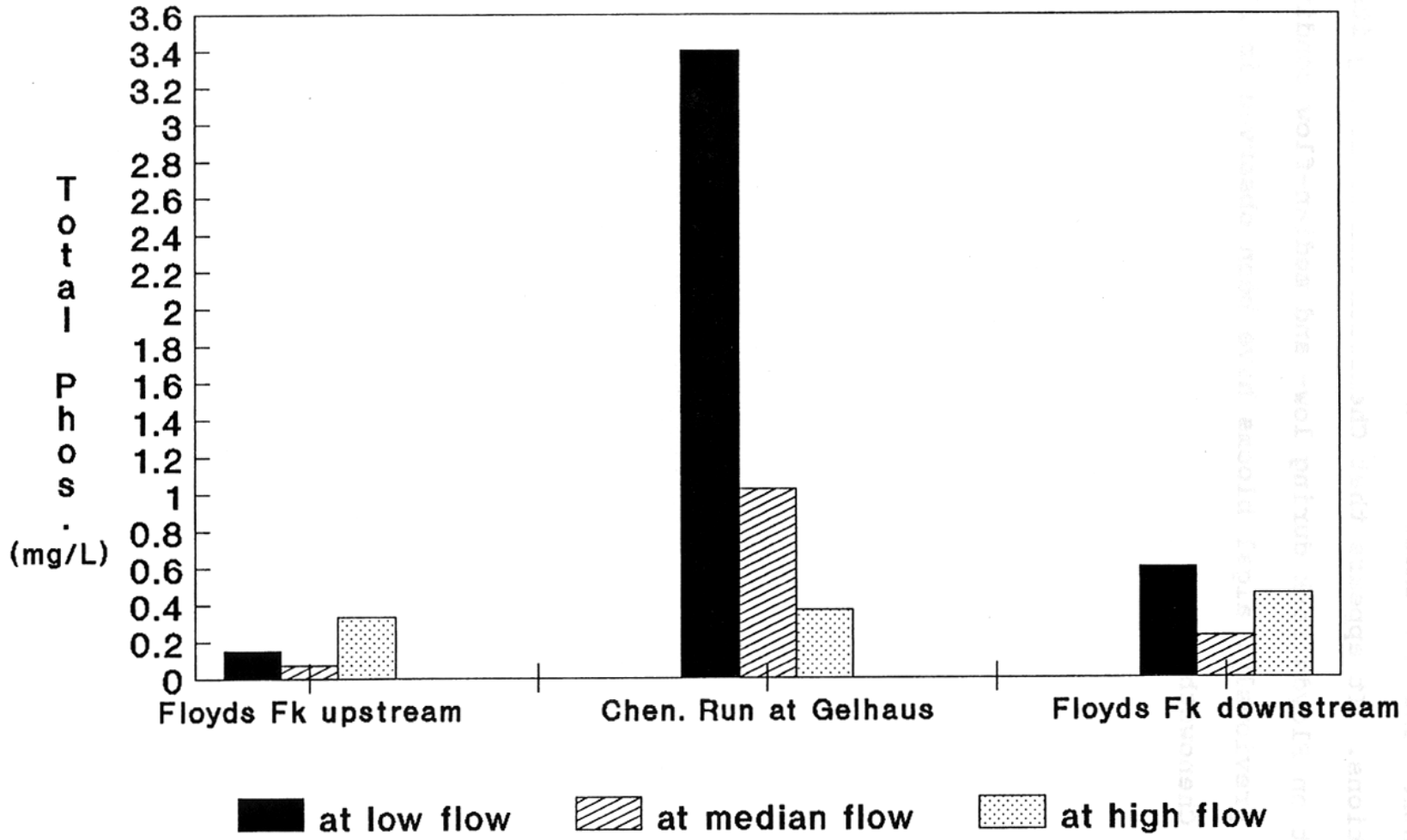
* Data taken from USGS Water Resources Investigations Report 94-4065, 1988 to 1992
** Data taken from USGS Water Resources Investigations Report 92-4150, 1988 to 1991
( ) Value estimated by USGS log-normal fit program

Table 4. Data in Floyds Fork and Chenoweth Run from 1988 to 1992 (cont)*

Station Name	Number of Observations	Minimum	PERCENTILES 10	25	50 (median)	75	90	Maximum
			Water Temperature (degrees C)**					
Floyds Fk at Taylorsville Rd	74	0.7	3.5	8.1	14	22	27	30
Chen. Run at Gelhaus Lane	73	0.0	4.9	8.0	15	21	25	32
Floyds Fk at Bardstown Rd	75	0.3	3.7	7.8	16	23	27	30
			Ammonia Nitrogen (mg/L as N)					
Floyds Fk at Taylorsville Rd	91	<.01	(<.01)	(<.01)	0.04	0.09	0.37	6.6
Chen. Run at Gelhaus Lane	88	<.01	(<.01)	(0.01)	0.09	0.36	0.76	6.8
Floyds Fk at Bardstown Rd	90	<.01	(<.01)	(0.01)	0.06	0.11	0.35	2.3
			Nitrate Nitrogen (mg/L as N)					
Floyds Fk at Taylorsville Rd	90	<.10	0.27	0.49	0.91	1.8	3.2	9.6
Chen. Run at Gelhaus Lane	89	0.14	1.3	2.1	3.7	5.7	11	21
Floyds Fk at Bardstown Rd	90	<.10	0.33	0.82	1.3	1.8	3.2	9.1

* Data taken from USGS Water Resources Investigations Report 94-4065, 1988 to 1992
** Data taken from USGS Water Resources Investigations Report 92-4150, 1988 to 1991
( ) Value estimated by USGS log-normal fit program

Figure 12. Total Phosphorus
Chenoweth Run & Floyds Fk, 1988 to 1992



concentrations at these locations during different hydrologic conditions. It appears that Chenoweth Run is having its greatest impact on Floyds Fork during low- and median-flow conditions. As noted previously, algal blooms have been observed in Floyds Fork below Chenoweth Run.

CONCLUSIONS AND RECOMMENDATIONS

Data collected for this study and previous studies show a variety of water quality problems in Chenoweth Run. During low to moderate flows, it appears that high phosphorus concentrations are severely impacting both Chenoweth Run and Floyds Fork downstream of Chenoweth Run. The primary source of this phosphorus is the J-town WWTP. At higher flow conditions, runoff from urban, industrial, and construction areas increases sediment concentrations, contributes to metal criteria violations, and adds nutrients and other chemicals.

Three measures are needed to achieve solutions to these problems: 1) phosphorus reduction at the J-town WWTP; 2) creation of riparian zones and tree planting to provide shade; 3) and storm water runoff controls. The specific amount of phosphorus reduction needed from the J-town WWTP cannot be discerned from existing data. MSD, in cooperation with the USGS, is undertaking a modeling study of Chenoweth Run that is expected to provide a more detailed answer to this question. (The study plan is attached as Appendix II.) If results of this study are not available at the next permit issuance (June 2000), or are inconclusive, the KDOW will require a 1 mg/L phosphorus limit for this facility. In the absence of stream criteria, 1 mg/L is the phosphorus value being applied on other Kentucky facilities discharging to flowing streams with documented nutrient problems. A more strict limit may also be applied in the future if nationwide research establishes specific stream criteria.

Follow-up monitoring of Chenoweth Run by the KDOW, or possibly MSD and the USGS, will be used to determine the effectiveness of this limit and other control measures. If algal blooms and associated water quality problems persist, further watershed control measures or additional phosphorus reduction may be necessary.

The KDOW believes that Chenoweth Run and all urban streams have the potential to fully meet state water quality criteria. The task will not be easy or inexpensive and will require the cooperation of both public and private entities. Regulatory controls at the end-of-pipe will not likely be successful without reductions in the use of lawn-care chemicals, effective sediment control structures in areas of construction, riparian zone creation and restoration, and effective storm water management.

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